

## Species composition and site distribution of spiders (Araneae) in a gneiss massif in the Dyje river valley

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**Species composition and site distribution of spiders (Araneae) in a gneiss massif in the Dyje river valley.** - The species-rich community of spiders in boulder debris and crevice-type caves of the "Ledové Sluje" gneiss massif in the Dyje river valley in southern Moravia (Czech Republic) is described. The community comprises both relict and synanthropic species, and both thermophilous and psychrophilous species, according to highly segmented environment with a variety of microclimatic conditions. The species composition of the spider communities is characterized along the gradient from the boulder debris surface down a depth of approximately ten metres in crevices of the rock massif. The spider biomass and species diversity seems to decrease with increasing depth of the underground spaces. The dominant species are *Pholcus opilionoides* on the debris field surface, *Lepthyphantes improbulus* at depths about 0.5–5 m, and *Porrhomma egeria* at depths larger than 5 m. The occurrence of species with progressing morphological adaptations to life in subterranean environment in the boulder debris and cavities of the gneiss massif gives evidence that these underground spaces, also in non-karst areas, play an important part in the underground evolution of invertebrates.

**Key-words:** Rocks – stony debris – pseudokarst – caves – spiders – diversity – troglomorphisms.

### INTRODUCTION

A highly diverse mosaic of microclimatic conditions occurs in slope boulder accumulations. Two important gradients establish, viz. between the upper and lower margins of the debris field and between the surface and inner spaces of the debris. Ecosystems of boulder debris can host isolated populations of invertebrates. Species exhibiting morphological adaptations to life in the subterranean environment have been found in depth of stony debris (RUŽIČKA & ZACHARDA 1994; RUŽIČKA *et al.* 1995).

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## STUDY SITE AND METHODS

The Dyje Valley National Park lies on the boundary of the Česká Vysocina highland and the Carpathians, that is, the boundary of the Mesophyticum and the Pannonian Thermophyticum (HEJNY & SLAVIK 1988). The elevated western part is characterized by ample rains, whereas in the lower-altitude eastern part, where the average temperature is higher, rains are less frequent. The deeply incised valley of the Dyje river enables fauna and flora of the two systems to combine. Meander necks and sunny sites host thermophilous plants whose isolated islets penetrate deeply into the Mesophyticum; and on the other hand, inversion in the valley allows submountain species to descend to low altitudes. On bare rocks facing the north and on boulder accumulations, i.e. primarily forestless nonxerothermal sites, vegetation occurs which is closely related to some mountain or even subalpine vegetation types (CHYTRY 1992).

Some three km to the SE of the town Vranov nad Dyjí the river Dyje forms a meander bypassing a spur called "Ledové Sluje", which means "Ice Caves". The whole massif consists of heavily creviced orthogneiss. In its upper part the meander spur is rimmed by steep rock walls under which there stretches a ditch-like depression

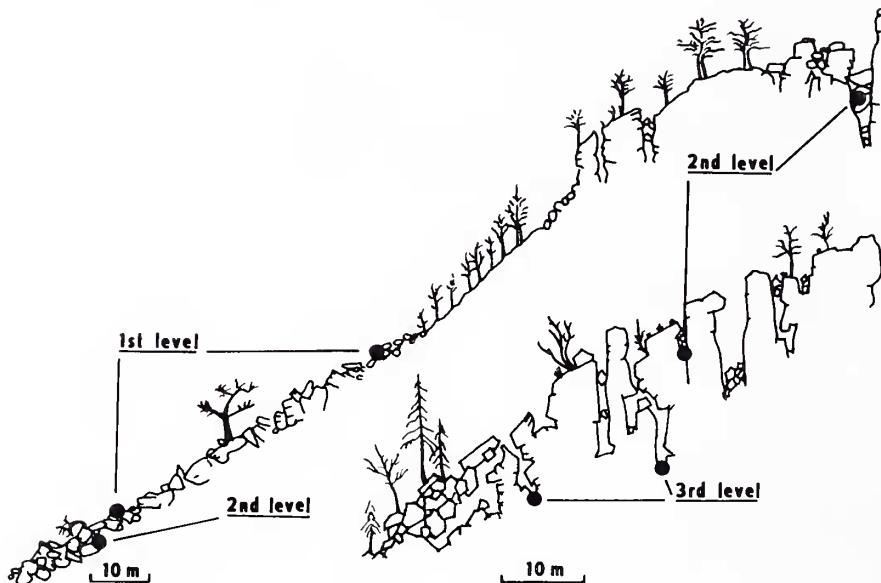


FIG. 1.

Schematic of the Ledové Sluje rocky spur profile (ZVELEBIL *et al.* 1996; KOPECKÝ 1996). Three space levels with characteristic dominant spider species are marked: 1st level – *Pholcus opilionoides*, 2nd level – *Leptophantes improbus*, 3rd level – *Porrhomma egeria*.

covered by broken rock blocks. Down the slope, gravitational motion of blocks of the creviced rock massif has given rise to a system of crevice-type caves, lying as deep as tens of metres. In some of them, ice forms and persists till summer (JARZ 1882; ŠPALEK 1935). Below this region of pseudo-ice caves, a bare block field about 100 m long and 100 m broad lies on the northwestern slope. The blocks, which constitute a stony debris formation, are on average 250 cm in size. Isolated herb tussocks and dwarf trees grow in the debris field (Fig. 1). Appreciable cold air movement was observed under the blocks at the lower margin of the debris. The temperature, measured with a minimo-maximal thermometer, ranged from -16 to +8°C at cold air movement sites over the period from 25 November 1992 to 25 October 1993.

Spiders were collected in 1992–1994 by hand picking and by using modified pitfall traps (RUŽIČKA 1982, 1988). The traps were laid on the surface of the debris (3 traps), between boulders inside the debris (9 traps), in boulder accumulations in the cave entrances (5 traps), as well as in caves (5 traps), where they were left for approximately one year. A total of 268 spider individuals belonging to 76 species were collected (Table 1).

TABLE I

Survey of material collected at the Ledové Sluje site within the 1992–1994 period. Explanation see in Methods.

species		♂/♀/juv.
Pholcidae		
T III	<i>Pholcus opilionoides</i> (Schrank, 1781)	10/10/9
Sekestriidae		
P II	<i>Segestria senoculata</i> (Linné, 1758)	1/2
Dysderidae		
T I	<i>Dysdera ninnii</i> Canestrini, 1868	-/1/1
N II	<i>Harpactea hombergi</i> (Scopoli, 1763)	-/1/3
P II	— <i>leptoides</i> (C.L. Koch, 1839)	-/1
T III	— <i>rubicunda</i> (C.L. Koch, 1839)	-/2
Mimetidae		
N II	<i>Ero furcata</i> (Villers, 1789)	-/1
Nesticidae		
? III	<i>Nesticus cellularis</i> (Clerck, 1757)	-/3/3
Theridiidae		
M II	<i>Achaearanea lunata</i> (Clerck, 1757)	2/-
T I	<i>Dipoena melanogaster</i> (C.L. Koch, 1845)	1/1
N III	<i>Enoplognatha ovata</i> (Clerck, 1757)	2/-
N II	<i>Episinus truncatus</i> Latreille, 1809	2/-
N I	<i>Pholcomma gibbum</i> (Westring, 1851)	1/-
? I	<i>Theonoe minutissima</i> (O. P.-Cambridge, 1879)	-/2
P I	<i>Theridion bellicosum</i> (Simon, 1873)	-/1
N III	— <i>bimaculatum</i> (Linné, 1767)	1/-
N III	— <i>sisyphium</i> (Clerck, 1757)	1/1
N III	— <i>varians</i> Hahn, 1833	1/-

## Linyphiidae

P	I	<i>Agyneta contigera</i> (O. P.-Cambridge, 1863)	-/4
N	III	<i>Centromerus sylvaticus</i> (Blackwall, 1841)	-/3
P	II	<i>Leptophantes alacris</i> (Blackwall, 1853)	1/4
P	II	— <i>cristatus</i> (Menge, 1866)	2/-
P	I	— <i>improbulus</i> Simon, 1929	21/21
M	III	— <i>leprosus</i> (Ohlert, 1865)	7/8
P	II	— <i>nitidus</i> Thorell, 1875	-/1
P	I	— <i>nodifer</i> Simon, 1884	-/5
P	I	— <i>obscurus</i> (Blackwall, 1841)	1/-
N	II	— <i>pallidus</i> (O. P.-Cambridge, 1871)	-/2
N	III	<i>Meioneta rurestris</i> (C.L. Koch, 1836)	1/1
N	II	<i>Microneta viaria</i> (Blackwall, 1841)	-/2
M	II	<i>Neriene radiata</i> (Walckenaer, 1841)	2/6
P	I	<i>Porrhomma egeria</i> Simon, 1884	4/5/1
N	III	— <i>microplithalmum</i> (O. P.-Cambridge, 1871)	-/1
P	II	— <i>pallidum</i> Jackson, 1913	-/1
P	II	<i>Saaristoa firma</i> (O. P.-Cambridge, 1901)	-/1/1
N	II	<i>Ceratinella brevis</i> (Wider, 1834)	1/-
M	I	— <i>major</i> Kulczynski, 1894	1/1
N	III	<i>Diplocephalus cristatus</i> (Blackwall, 1833)	-/1
N	II	— <i>latifrons</i> (O. P.-Cambridge, 1863)	1/1
N	II	— <i>picinus</i> (Blackwall, 1841)	1/1
P	I	<i>Glyphesis servulus</i> (Simon, 1881)	1/-
M	I	<i>Kratochviliella bicapitata</i> Miller, 1939	5/3
P	II	<i>Maso sundevalli</i> (Westring, 1851)	-/1
P	III	<i>Micrargus herbigradus</i> (Blackwall, 1854)	5/1
?	I	<i>Pelecopsis nemoralis</i> (Blackwall, 1841)	1/1
N	II	<i>Trematocephalus cristatus</i> (Wider, 1834)	1/-

## Tetragnathidae

P	III	<i>Meta menardi</i> (Latreille, 1804)	1/-/4
P	III	<i>Metellina merianae</i> (Scopoli, 1763)	-/-/1
N	III	<i>Pachygnatha degeeri</i> Sundevall, 1830	-/1

## Araneidae

N	III	<i>Araniella cucurbitina</i> (Clerck, 1757)	-/3
N	III	<i>Araneus diadematus</i> Clerck, 1757	1/-
N	III	<i>Mangora acalypha</i> (Walckenaer, 1802)	1/-
T	I	<i>Zilla diodia</i> (Walckenaer, 1802)	3/-

## Lycosidae

N	II	<i>Pardosa lugubris</i> (Walckenaer, 1802)	2/1
N	II	<i>Xerolycosa nemoralis</i> (Westring, 1861)	2/2

## Agelenidae

N	III	<i>Cicurina cicur</i> (Fabricius, 1793)	3/1
P	II	<i>Histopona torpida</i> (C.L. Koch, 1834)	1/-
?	III	<i>Tegenaria ferruginea</i> Panzer, 1804	2/-
N	II	— <i>silvestris</i> L. Koch, 1872	2/2/1
N	II	<i>Textrix denticulata</i> (Olivier, 1789)	-/2

## Dictynidae

T	I	<i>Bronella falcigera</i> (Balogh, 1935)	1/1
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## Amaurobiidae

P	II	<i>Amaurobius fenestralis</i> (Stroem, 1768)	1/3
T	I	— <i>jugorum</i> (L. Koch, 1868)	1/-
P	II	<i>Callobius claustrarius</i> (Hahn, 1831)	2/1/1

## Liocranidae

N	III	<i>Liocranum rupicola</i> (Walckenaer, 1830)	3/-
M	I	— <i>rutilans</i> (Thorell, 1875)	1/1
N	II	<i>Phrurolithus festivus</i> (C.L. Koch, 1835)	-1

## Gnaphosidae

N	II	<i>Drassodes lapidosus</i> (Walckenaer, 1802)	2/-
N	I	<i>Echemus angustifrons</i> (Westring, 1861)	1/3

## Zoridae

N	II	<i>Zora spinimana</i> (Sundevall, 1833)	-1/1
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## Salticidae

M	II	<i>Evarcha arcuata</i> (Clerck, 1757)	-1
?	I	<i>Heliophanus aeneus</i> (Hahn, 1831)	-4
T	II	— <i>cupreus</i> (Walckenaer, 1802)	1/-
?	I	— <i>melinus</i> L. Koch, 1867	1/-
M	II	<i>Neon reticulatus</i> (Blackwall, 1853)	2/-
N	III	<i>Salticus scenicus</i> (Clerck, 1757)	-1

The material was identified and evaluated with respect to the occurrence of the species in phytogeographical regions and in habitats of various degree of originality (BUCHAR 1992): T – occurring prevailingly in western part of Thermophyticum, M – occurring prevailingly in Mesophyticum, O – occurring prevailingly in Oreophyticum, N – non-specific. I – occurring in natural habitats corresponding to climatic or edaphic climax, II – species capable of occupying some shadow and wet secondary, semi-natural habitats (cultural forests, shrubs, cultivated wetlands), III – species capable of forming viable populations in artificially deforested, man-made habitats (fields, meadows, spoil banks, and urban biotopes). For the specimens in traps, the spider activity (after RUŽIČKA 1987a), spider dry weight (after BREYMEYER 1969) and Shannon's index of diversity were calculated.

## RESULTS AND DISCUSSION

The frequency of specimens of species occurring prevailingly in natural habitats in the collection from pitfall traps is 0.43, which is considerably higher than the minimal value of 0.20 that is characteristic for protected regions in the Czech Republic (RUŽIČKA 1987b), despite the fact that the site hosts the following hemisynthropic species (sensu SACHER 1983): *Harpactea rubicunda*, *Segestria senoculata*, *Lepthyphantes leprosus*, *Nesticus cellularius*, *Liocranum rupicola*, *Amaurobius fenestralis*, and *Salticus scenicus*. Those are species which are classed as "occupying man-made biotopes" in BUCHAR's categorization (BUCHAR 1992). Actually, however,

typical opportunistic species of this category inhabit unstable environment, such as sites of field cultures; they are typical r-strategists with a high reproductive potential and a high spreading capacity. Hemisynthropic species, on the other hand, inhabit relatively stable environment of human dwellings, which is not dissimilar to the natural stable environment of stony and rocky biotopes. The group of hemisynthropic species could be classified as separate group. Simultaneous occurrence of relict and synthropic species is a characteristic feature of stony debris (RUŽIČKA 1989).

The whole collection contains 21 species occurring prevailingly in original habitats. Five of those, viz. *Dysdera ninnii*, *Dipoena melanogaster*, *Zilla diodia*, *Bromella falcigera*, and *Amaurobius jugorum* were found principally in Thermophyticum, whereas other seven, viz. *Theridion bellicosum*, *Agyneta conigera*, *Lepthyphantes improbulus*, *L. nodifer*, *L. obscurus*, *Porrhomma egeria*, and *Glypesis servulus* seem to prefer the Oreophyticum. Simultaneous occurrence of species of these two categories in stony debris has already been observed by BUCHAR *et al.* (1979) and by RUŽIČKA (1989, 1994). Hence, stony biotopes with many underground cavities contribute significantly to the biodiversity of landscape (Ruzicka 1993). What are the causes for the observed species diversity?

The northwestern orientation, owing to which the site is partly sunny, facilitates the occurrence of thermophilous species, which occupy the surface boulder layer heated by solar rays (*Dysdera ninnii*, *Amaurobius jugorum*). Isolated trees and vegetation tussocks do not shade the stony debris and enable thermophilous web-forming species (*Dipoena melanogaster*, *Zilla diodia*) to live there. Air movement through the extensive system of underground cavities is responsible for an all-year cold microclimate at the lower margin of the debris field. Owing to this, the psychrophilous species *Agyneta conigera*, *Lepthyphantes nodifer*, *L. obscurus*, and *Glypesis servulus* are found there in moss and detrite.

The decaying gneiss massif forms a wide variety of underground spaces. The spider biomass as well as the species diversity seems to decrease from the surface downwards (Table 2). With respect to the species composition similarity, three space levels were detect (Table 3, Fig. 1). *Pholcus opilionoides* is the dominant species on the debris surface, *Lepthyphantes leprosus* is here also numerous. *Lepthyphantes improbulus* is the most abundant species in the material. It was observed in all the spaces examined, with a maximum occurrence at 2–3 m depths, under blocks and in the entrance holes of the caves, at sites with fine soil. *Porrhomma egeria* only occurred in deep lying caves of the massif, at depths larger than 5 m where soil is rather compact and is wet constantly.

Morphological adaptations to life in caves – troglomorphisms (sensu ZACHARDA 1979) – are known for two of the species observed. MORITZ (1972) found that in comparison with specimens trapped in Pyrenean forests, the central European populations of *Lepthyphantes improbulus* have longer legs and their eye lenses are less bulged. *Porrhomma egeria* is the only spider species occupying regularly deep cavernous spaces in central Europe. SANOCKA (1982) described a gradual eye reduction for this species in dependence on the site distance from the cave entrance.

TABLE 2

Survey of characteristics of spider material from pitfall traps. No – number of a trap, D – depth (m), A – activity (ind.m<sup>-1</sup>.year<sup>-1</sup>), W – dry weight (mg.m<sup>-1</sup>.year<sup>-1</sup>), H' – Shannon's index of diversity. Correlation coefficients: A: -0.31, p = 0.155; W: -0.51, p < 0.05; H': -0.48, p < 0.05.

No	1	2	3	4	5	6	7	8	9	10	11
D	0	0	0	0.4	0.5	0.7	0.7	1.5	1.5	2	2
A	44	62	56	21	12	9	9	3	24	44	27
W	337	167	187	72	8	7	159	2	111	50	140
H'	2.2	2.7	3.1	2.5	1.5	0.9	0.9	0	2.3	2.3	2.8

No	12	13	14	15	16	17	18	19	20	21	22
D	2	2	2	2.5	3	3	6	7	7	10	10
A	6	81	29	33	20	16	34	12	24	4	16
W	136	37	93	57	86	48	50	32	27	2	8
H'	1.0	1.8	1.8	1.6	1.4	1.5	2.5	1.6	1.8	0	0

TABLE 3

Survey of species tied to stony and underground biotopes as caught in pitfall traps (numbers of specimens in three depth levels).

species	surface	0.5–5 m	5–10 m
<i>Pholcus opilionoides</i>	20	—	—
<i>Echemus angustifrons</i>	4	—	—
<i>Liocranum rupicola</i>	3	—	—
<i>Liocranum rutilans</i>	2	—	—
<i>Drassodes lapidosus</i>	2	—	—
<i>Heliophantus aenaeus</i>	1	—	—
<i>Histopona torpida</i>	1	—	—
<i>Tegenaria ferruginea</i>	1	—	—
<i>Porrhomma pallidum</i>	1	—	—
<i>Theonoe minutissima</i>	1	—	—
<i>Leptophantes leprosus</i>	10	5	—
<i>Segestria senoculata</i>	1	1	—
<i>Tegenaria silvestris</i>	2	3	—
<i>Theridion bellicosum</i>	—	1	—
<i>Meta menardi</i>	—	3	—
<i>Cicurina cicur</i>	—	4	—
<i>Kratochviliella bicapitata</i>	2	2	3
<i>Leptophantes improbulus</i>	3	32	2
<i>Nesticus cellularius</i>	—	5	1
<i>Leptophantes alacris</i>	—	1	2
<i>Leptophantes nitidus</i>	—	—	1
<i>Porrhomma egeria</i>	—	—	10

Hence, two spider species exhibiting a process of adaptation to life underground have been observed in stone block debris and crevices in the massif at the Ledové Sluje site. This documents the importance of shallow subterranean spaces for the underground evolution of invertebrates, and disproves the hypothesis that only deep karst caves are of importance to this evolution (VANDEL 1965).

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#### REFERENCES

- BREYMEYER, A. 1969. The rate of reduction of the density and the change in the biomass of the *Lycosa pullata* (Clerck) (Lycosidae, Araneida) population in a meadow environment. *Bulletin du Muséum National d'Histoire Naturelle, Paris, 2e Sér.*, Tome 41, Suppl. 1: 211–216.
- BUCHAR, J. 1992. Komentierte Artenliste der Spinnen Böhmens (Araneida). *Acta Universitatis Carolinae – Biologica* 36: 383–428.
- BUCHAR, J., ANTUŠ, M., HAJER, J., POTUŽÁKOVÁ, H. & ŠTEIGEROVÁ, A. 1979. Arachnofauna aus dem Tale Brná nad Labem. *Fauna Bohemiae Septentrionalis (Ústí nad Labem)* 4: 77–92.
- CHYTRY, M. 1992. Bemerkungen zur Vegetation der primär waldfreien Flächen auf nicht-xerothermen Standorten in Flusstäler des Südostrandes des Böhmisches Massivs. *Acta Musei Moraviae, Scientiae naturales*, 77: 123–137.
- HEJNY, S. & SLAVIK, B. 1988. Flora of the Czech Socialist Republic I. *Academia, Praha*, 559 pp.
- JARZ, K. 1882. Die Eishöhlen bei Frain in Mähren. A. *Petermann's Mittheilungen aus Justus Perthes' geographischer Anstalt* 28: 170–176.
- KOPECKÝ, J. 1996. Investigation and survey of pseudokarst caves “Ledové sluje” in the Podyjí National Park (Czech Republic), pp. 7–26. In: Investigation of the locality “Ledové sluje” (Ice caves) near Vranov nad Dyji (Podyjí National Park). *Příroda – Sborník prací z oboru ochrany přírody*, Vol. 3. (GRUNA, B. & REITER, A. ed.). Agentura ochrany přírody a krajiny České republiky, Praha.
- MORITZ, M. 1972. *Lepthyphantes improbulus* Simon, 1929, eine troglobionte Spinne des Kyffhäusergebirges. *Deutsche entomologische Zeitschrift*, N.F., 19(4–5): 307–314.
- RUŽIČKA, V. 1982. Modifications to improve the efficiency of pitfall traps. *Newsletter of the British Arachnological Society* 34: 2–4.
- RUŽIČKA, V. 1987a. An analysis of spider communities in the meadows of the Třeboň basin. *Acta scientiarum naturalium Academiae scientiarum bohemoslovacae, Brno*, 21(5): 1–39.
- RUŽIČKA, V. 1987b. Biodiagnostic evaluation of epigeic spider communities. *Ekológia (ČSSR)* 6: 345–357.
- RUŽIČKA, V. 1988. The longtimely exposed rock debris pitfalls. *Věstník československé společnosti zoologické* 52: 238–240.
- RUŽIČKA, V. 1989. Spider (Araneae) communities of rock debris on a typical hillside in the České Středohoří Mts. (North Bohemia). *Acta Entomologica Bohemoslovaca* 86: 419–431.
- RUŽIČKA, V. 1993. Stony debris ecosystems – sources of landscape diversity. *Ekológia (Bratislava)* 12(3): 291–298.
- RUŽIČKA, V. 1994. Spiders of the Pručelská Rokle defile, Klíč Mt. and Zlatník Mt. in North Bohemia. *Fauna Bohemiae Septentrionalis (Ústí nad Labem)* 19: 129–138.

- RUŽIČKA, V., HAJER, J. & ZACHARDA, M. 1995. Arachnid population patterns in underground cavities of a debris field (Araneae, Opiliones, Pseudoscorpionidea, Acari: Prostigmata: Rhagidiidae). *Pedobiologia* 39: 42–51.
- RUŽIČKA, V. & ZACHARDA, M. 1994. Arthropods of stony debris in the Krkonoše Mountains, Czech Republic. *Arctic and Alpine Research* 26(4): 332–338.
- SACHER, P. 1983. Spinnen an und in Gebäuden. Versuch einer Analyse der synanthropen Spinnentafauna in der DDR, II. *Entomologische Nachrichten und Berichte* 27(4): 141–152.
- SANOCKA, E. 1982. Eye regression in Porrhomma moravicum Mill. et Krat. (Aranei). *Zoologica poloniae* 29(1–2): 13–21.
- ŠPALEK, V. 1935. Les grottes de glace de Vranov nad Dyjí. *Sborník Československé společnosti zeměpisné* 41: 49–55.
- VANDEL, A. 1965. Biospeleology. The biology of cavernicolous animals. *Pergamon Press, Oxford*, 525 pp.
- ZACHARDA, M. 1979. The evaluation of the morphological characters in Rhagidiidae, pp. 509–514. In: Recent advances in acarology. Voll. II (RODRIGUEZ, J.G. ed.). Academic Press, New York.
- ZVELEBIL, J., NOVOTNY, J., KOŠTÁK, B., & ŽIKA, P. 1996. Preliminary results of engineering-geological study of slope deformation of Ledové sluje crest, pp. 41–54. In: Investigation of the locality “Ledové sluje” (Ice caves) near Vranov nad Dyjí (Podyjí National Park). Příroda – Sborník prací z oboru ochrany přírody, Vol. 3. (GRUNA, B. & REITER, A. ed.). Agentura ochrany přírody a krajiny České republiky, Praha.